Claims

1. Inertial sensor based on diamagnetic levitation, said inertial sensor comprising a two dimensional array of permanent magnets and a diamagnetic element facing the said array **characterized** in that said diamagnetic material constitutes the inertial mass.

2. Inertial sensor according to claim 1 wherein said array is a bi-dimensional arrangement of permanent magnets called "Halbach 2D" which is characterised by the fact that:
   - some of its constituting magnets are pointing in a direction Z orthogonal to the XY plan defining said array
   - the magnetic field lines are mostly concentrated on one side of the said array and with very few magnetic field lines on the other side of said array.
   - along each of the two directions X and Y defining said "Halbach 2D" array of permanent magnets, one can see linear Halbach arrangements of permanent magnets : the polarities of adjacent magnets (along one direction) differ by an increments of 90°.
   - in order to avoid breaking the symmetry of the flux lines there are some missing magnets in the said array, and those missing magnets are located along directions parallel to the X+Y direction of the said magnet and in between 2 magnets with the same vertical polarisation.

3. Inertial sensor according to claim 1 or 2 furthermore comprising a feed-back loop incorporating :
   - at least 1 non contact position sensor to detect the movements of said inertial mass
   - at least 3 electrostatic actuators for keeping in place or moving said inertial mass

- and computing means to derive the solicitation exerted on said support means and for moving or keeping in place said inertial mass accordingly;

wherein said electrostatic actuators have one common electrode which is physically sealed to said inertial mass, the other electrode of each said electrostatic actuator facing and partly surrounding, or being partly surrounded by, said common electrode.

4. Inertial sensor according to claim 3 comprising :

- two pairs of electrodes
- a 4 segments optical sensor
- a LED or laser source

wherein said inertial mass is a disc of diamagnetic material surrounded by an aluminium crown thus constituting said common electrode; and

wherein said pairs of electrodes are diametrically facing said aluminium crown, each said pair of electrodes being placed orthogonally to the other pair of electrodes;

and wherein said 4 segments optical sensor and said LED or laser source are respectively facing an opposite face of the surface delimited by said inertial disc shaped mass;

and wherein said inertial mass has a hole in its centre from which the light of said LED or laser source is spotting on said 4 segments optical sensor.

5. Inertial sensor according to claim 3 comprising :

- two pairs of electrodes
- two pairs of non contact position sensor

wherein said inertial mass is a disc of diamagnetic material surrounded by an aluminium crown thus constituting said common electrode; and

wherein said pairs of electrodes are diametrically facing said aluminium crown, each said pair of electrode being placed orthogonally to the other pair of electrode;

wherein said pairs of non contact position sensor are diametrically facing said aluminium crown , each said pair of electrode being placed orthogonaly to the other pair of electrode;

6. Use of an inertial sensor according to any of the previous claims as a bi-directional non-contact accelerometer or a bi-directional non contact seismometer.

7. Use of an inertial sensor according to any of the previous claims as a non contact bi-directional inclinometer or tiltmeter.

8. Use of an inertial sensor according to any of the previous claims as a non contact gravimeter.

9. Inertial sensor according to claim 3 or 4 or 5 wherein said inertial mass has a cylindrical shape; and
wherein said electrostatic electrodes are positioned regularly spaced on the surface of a cylinder facing said common electrode of said electrostatic actuator; and
wherein said common electrode of said electrostatic actuators is covered by a layer of pre-charged electret and the other electrode of each of said electrostatic actuator is made of at least three independent electrostatic alternating combs so as to create a rotating electric field that can spin said inertial mass.

10. Use of an inertial sensor according to claim 9 as non contact gyroscope

11. Bi-directional actuator based on diamagnetic levitation, said bi-directional actuator comprising support means serving as main support body for a bi-directional actuator, a two dimensional array of permanent magnets and a diamagnetic material facing the said array **characterized** in that said diamagnetic material constitutes the moving part of the actuator.

12. Bi-directional actuator according to claim 11 wherein said array is a bi-dimensional arrangement of permanent magnets called "Halbach 2D" which is characterised by the fact that:

- some of its constituting magnets are pointing in a direction Z orthogonal to the XY plan defining said array
- the magnetic field lines are mostly concentrated on one side of the said array and with very few magnetic field lines on the other side of said array.
- along each of the two directions X and Y defining said "Halbach 2D" array of permanent magnets, one can see linear Halbach arrangements of permanent magnets : the polarities of adjacent magnets (along one direction) differ by an increments of 90°.
- in order to avoid breaking the symmetry of the flux lines there are some missing magnets in the said array, and those missing magnets are located along directions parallel to the X+Y direction of the said magnet and in between 2 magnets with the same vertical polarisation.

13. Bi-directional actuator according to claim 11 or 12 furthermore comprising a feed-back loop incorporating :

- at least 1 position sensor to detect the movements of said moving part of the actuator
- at least 3 electrostatic actuators for keeping in place or moving said moving part of the actuator
- and computing means to move or keep in place said moving part of the actuator;

wherein said electrostatic actuators have one common electrode which is physically sealed to said inertial mass, the other electrode of each said electrostatic actuator facing and partly surrounding, or being partly surrounded by, said common electrode.

14. Bi-directionnal actuator according to claim 13 comprising :

- two pairs of electrodes
- a 4 segments optical sensor
- a LED or laser source

wherein said inertial mass is a disc of diamagnetic material surrounded by an aluminium crown thus constituting said common electrode; and wherein said pairs of electrodes are diametrically facing said aluminium crown , each said pair of electrode being placed orthogonaly to the other pair of electrode;

and wherein said 4 segments optical sensor and said LED or laser source are respectively facing an opposite face of the surface delimited by said inertial disc shaped mass;

and wherein said inertial mass has a hole in its center from which the light of said LED or laser source is spotting on said 4 segments optical sensor.

15. Bi-directional actuator according to claim 13 comprising :

- two pairs of electrodes
- two pairs of non contact position sensor

wherein said inertial mass is a disc of diamagnetic material surrounded by an aluminium crown thus constituting said common electrode; and

wherein said pairs of electrodes are diametrically facing said aluminium crown , each said pair of electrodes being placed orthogonaly to the other pair of electrodes;

wherein said pairs of non contact position sensor are diametrically facing said aluminium crown , each said pair of electrode being placed orthogonaly to the other pair of electrode;

16. bi-directional actuator according to claim 13 or 14 or 15 comprising:

- At least two additional electrostatic electrodes placed in such a way that said diamagnetic material is placed in between each of these two additional electrodes; said diamagnetic material playing the role of a common electrode in the 2 new electrostatic actuators constituted by the association of said additional electrostatic electrodes and said diamagnetic material.

- At least an additional non contact position sensor to measure the position of the said diamagnetic material with respect to said additional electrodes;

wherein said diamagnetic element is a flat shaped diamagnetic material; and wherein said position sensor is incorporated in a feedback loop with said additional electrostatic actuators and said computing means.

17. Use of a Bi-directional actuator according to claim 16 as a scanning module for an Atomic Force Microscope probe, said AFM probe being fixed on said diamagnetic material facing said hole in said 2D arrangement of permanent magnets; the element to be scanned being positioned inside said hole, under said AFM probe.